Computer-generated urban Structures

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Abstract

How does it come to particular structure formations in the cities and which strengths play a role in this process?

On which elements can the phenomena be reduced to find the respective combination rules?

How do general principles have to be formulated to be able to describe the urban processes so that different structural qualities can be produced?

With the aid of mathematic methods, models based on four basic levels are generated in the computer, through which the connections between the elements and the rules of their interaction can be examined. Conclusions on the function of developing processes and the further urban origin can be derived.

1. Introduction

The direct or indirect sense of this work is to inquire how the parameters that have generated existing urban structures can be transformed into mathematical controlling terms to achieve a new comprehension of the urban development. The results build the basis for the experimentation with the structural attributes. Furthermore the basic and efficient producing alternative solutions can be enabled and effectual mathematic models can be created. From these mathematical models urban developing processes can be simulated, interpreted and prognosticated.

2. The four basic Levels

2.1 Information Level

The information level is a possibility to work up these information that can not be reduced on elementary components. These components have to be assumed as given. There the contextual basis can be found which the system of the superior levels accesses like a databank to modify their parameters.

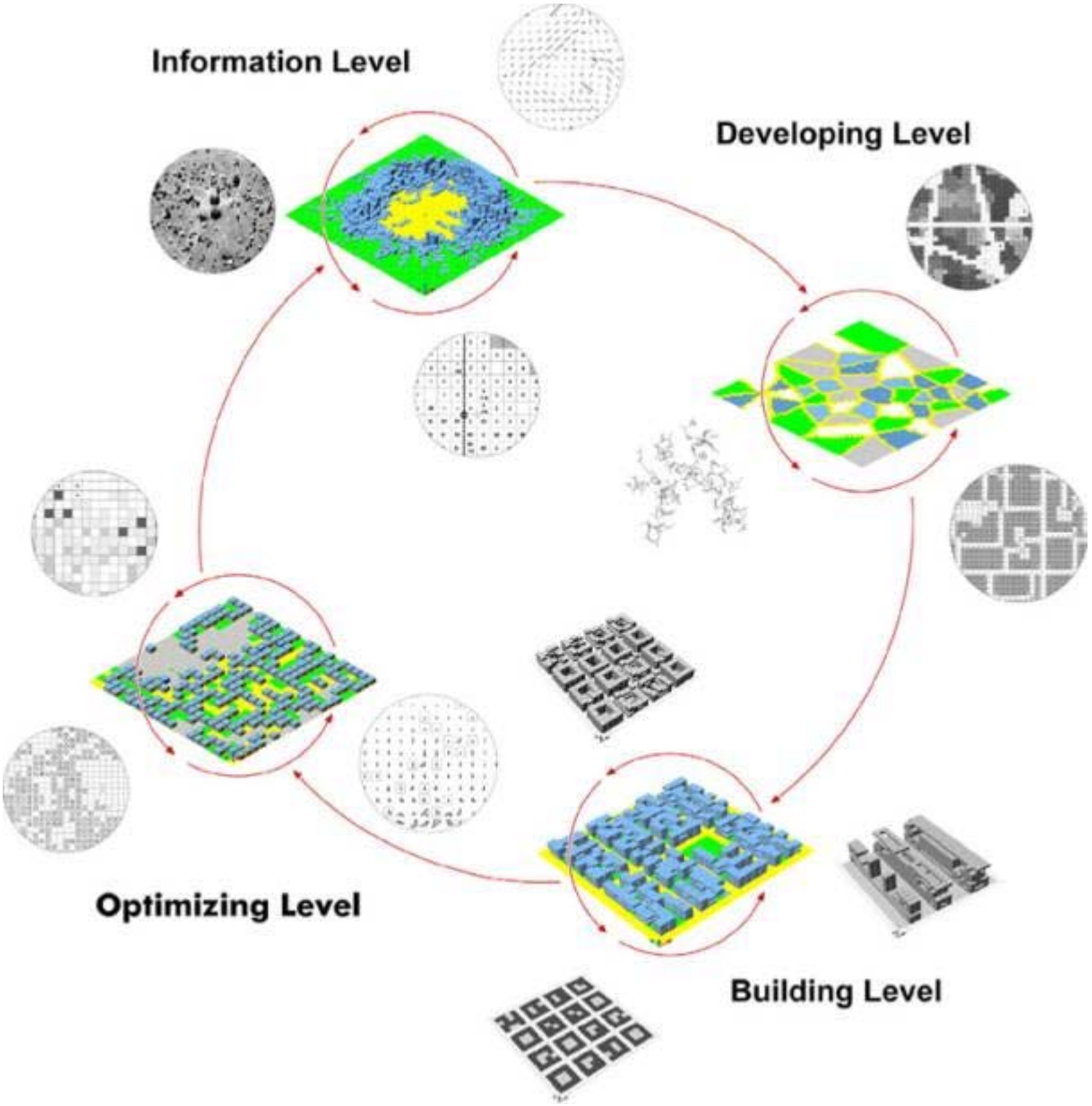

Figure 1 The four basic levels

2.2 Developing Level

One of the main structuring elements of a city is the organisation of the road network, which is closely connected to parcelling. By controlling connecting processes, different compartment types can be generated and by combining these types all kind of urban structures can be built.

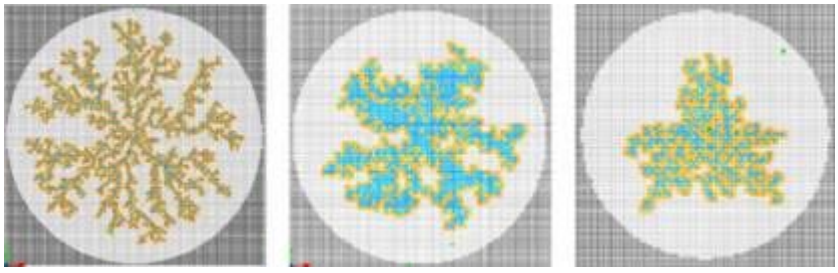

Figure 2 To generate the developing system, we inquired in the first step the behaviour of connecting systems around the controlling parameters that come to different structural attributes.

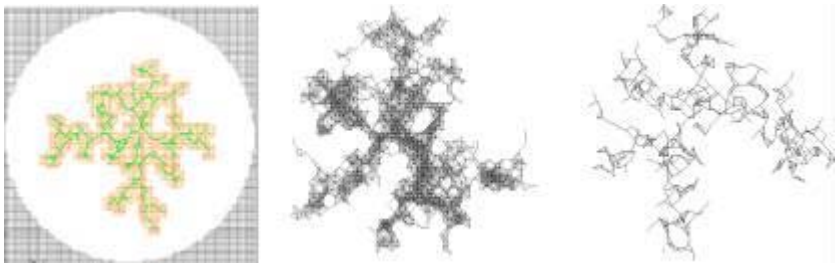

Figure 3 These generated systems will be transformed into road systems were the demands on the system will be extended, which can for example be seen from the composition of the knots.

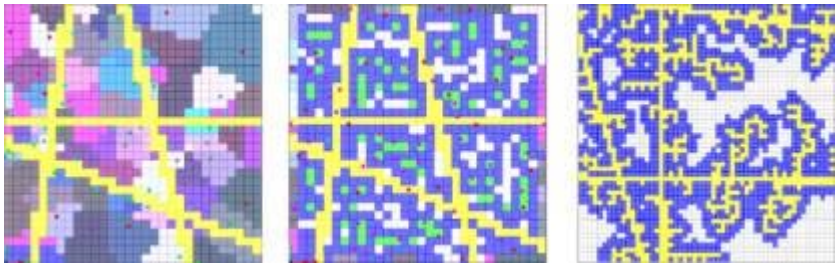

Figure 4 The introduction of the different agent types which have different agglomeration qualities is leading to the six "Feldtypen" of Klaus Humpert [14] by means of whom the complete spectrum of city structures can be produced.

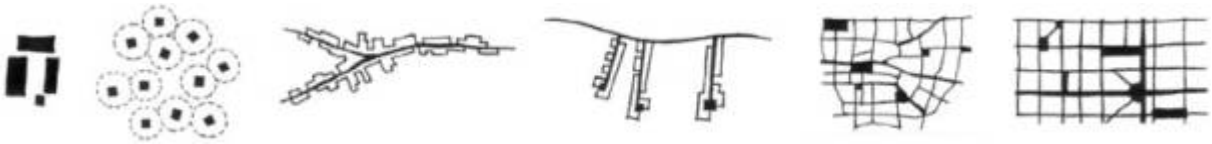

Figure 5 The Six Feldtypen : Nukleus, Cluster, Wegelagerer, Ausleger, Vernetzer, Plan [14]

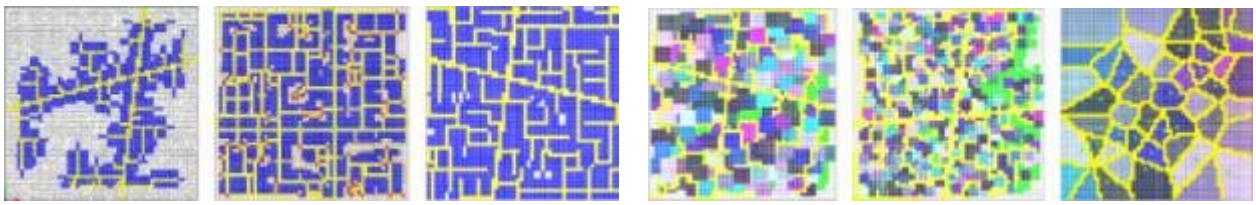

Figure 6 During the examination a closed connection can be proved between the road system and the parcelling structure.

2.3 Building Level

The frame of this level is developing different experiments how different three dimensional building structures can be generated in a preconceived road grid to light up attributes of the used models, which make them valuable for further architectonical applications.

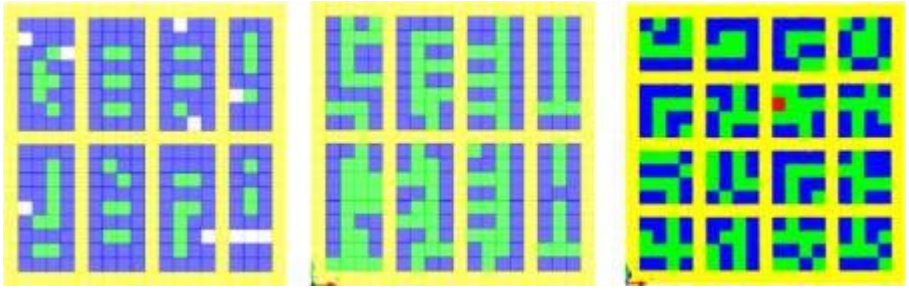

Figure 7 To generate three dimensional building structures cellular automata have been used. In the first step the cell to be build on (blue) of a parcel in dependence on the free neighbours (green) were defined. The size of the parcel that is deduced of the road system (yellow) plays an elementary role.

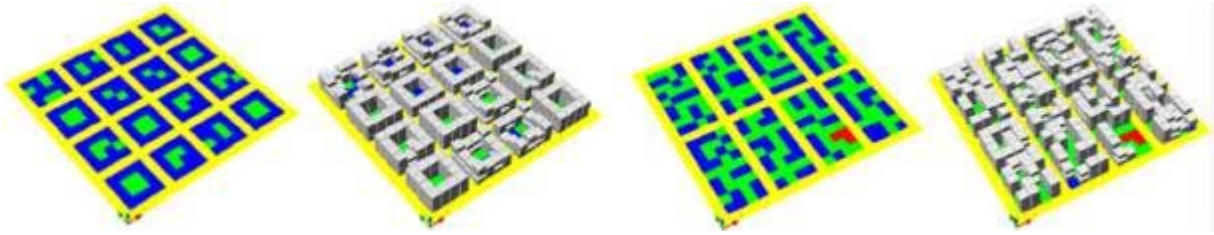

Figure 8 On the basis of the structuring of the parcels the character of the laminar specification of a spatial structure is translated by using a three dimensional cellular automata. Closed block buildings and liberal organization forms are distinguished.

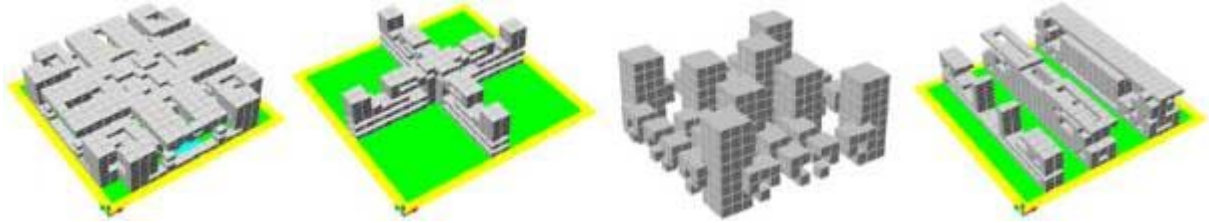

Figure 9 Furthermore, tree dimension cellular automata which can develop freely in the space and are only reduced by the streets and the cells to be kept free (red) can be constricted.

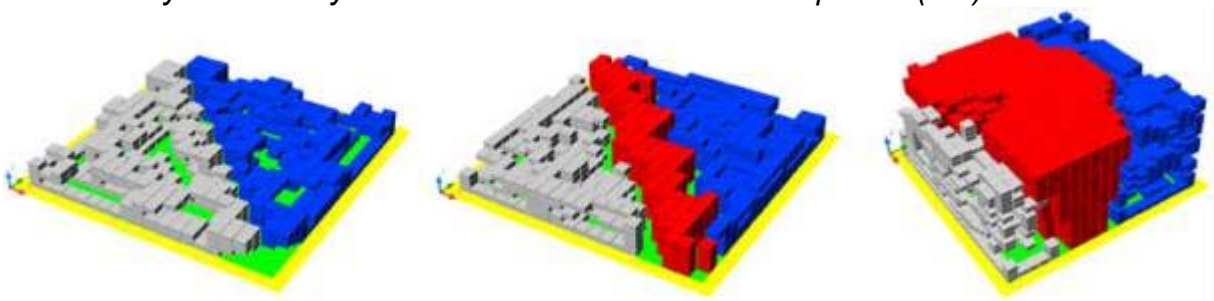

Figure 10 In the last step, systems for the separation distance will be examined, whereby statistic fields are used or dynamic cells (red) are introduced. They are created in-between where two building structures are approaching.

2.4 Optimizing Level

This level deals with methods that allow the rebuilding of given structures with regard to special criteria. This can be an allegation like land use, solar radiation, aeration, rational parcelling, minimizing the road network and others.

3. Application and development Possibilities

3.1 First Thesis

Huge construction projects are primarily developed by private investors. The public hand retires mainly from its responsibility. This is the reason why economic points of views are in the foreground and urban development qualities and social interests are treated secondarily.

- A strategy has to be found to convince the investors interests and to nevertheless convey the architectonic qualities from which the public benefits.

- An economically optimal usage of the property has to be ensured. This means greatest possible agriculturally productive lands in dependence of GRZ and BGF as a basis for profitable buildings.

- Therefore we have to develop a computer programme that fulfils these restrictions and at the same time uses these requirements as a strategic basis for the derivation of high quality spatial configurations, i.e. does not try to overcome the monotonous standard solutions with aesthetics but with economic arguments.

- The reversed argument that the architects make themselves superfluous can not be valid because of the written thoughts at the beginning of the chapter. Furthermore, the architects have dissociated themselves from this activity field and left the decision competence to the project developers and general over-recipients.

3.2 Second Thesis

From the economic compulsions a shortening of the planning periods arises for the development of the project developments. Therefore, a standardised design process usually accesses standardised solution patterns instead of searching for an optimal and demanding conception. The quality optimization in competitions remains a rare reason for private investors.

- The use of the computer as a creative planning instrument under correct application improves beside the quality also the rationality of the design process.

- Once the rules (genotypes) are found for a structure which has proved also in the practice, these rules can be used for a further planning. The development of the planning, however, depends on the environment so that the result (Phenotype) can be distinguished.

- Through this it becomes possible to go back to proven solution samples without exhausting oneself in flat copies. Merely the characteristics of a design are taken.

- By the strategies of combination and selection several successful rules can be deduced to reach further optimized solutions.

3.3 Third Thesis

The instruments of the development scheme can confirm the way of use and distribution and make rudimentary specifications for a spatial design over making limits and lines and the usage code numbers. The development scheme is derived in the best case of an urban development competition, taken place in the front-end.

- The structural rules for a development scheme can be decided on the parameters of the program, by means of those rules the possibilities of the constructability can be defined. (Genotypes and Phenotypes)

- Distance areas and building limits can be solved far more flexible if one makes the parameters dependent of each other and the primary sense of these rules derives on the calculation of the exposure and simultaneously makes the building possibilities obvious. A good example is Watanabe Sun Good city centre.

- The expenditure of energy for the construction and use of a way system or a building structure can be calculated and optimized.

3.4 Fourth Thesis

The social consequences prove only after the realization of the projects. The social utopian approaches of the classic modern age have let their weaknesses get visible in the apartment and settlement making primarily after their putting into action.

- The developed models can be extended by social components, whereby social processes, provided that they are statistically ascertainable, can flow into the simulation.

- This offers the possibility of looking at the thought of the participating planning from another point of view. It is no longer necessary to include the wishes and needs of the future users in particular what, due to the fact that these usually are often not confessed at the time of the planning, led to the failure. The stochastic processes of social dynamics can be simulated by means of agent systems.

- The spatial planning can be examined with its social consequences through this and the modelling of social processes the other way round serves as a basis for the spatial planning.

3.5 Fifth Thesis

Since only the great metropolises have to reckon with a permanent increase in population, besides the new planning of municipal areas strategies for the reorganization and the restructuring of existing city structures will become increasingly necessary up to the re-building in future. This means that it is necessary to operate within the complex, municipal structures and various possible developments have to be.

- All relevant data of existing structures can be comprehended over the information level.

- These serve as a basis for the restructuring after new aim criteria by means of the optimization level which makes possible a deconstruction and rebuilding.

- As described in the Fourth Thesis variances can be scrutinised for their social effects.

Besides the rational analysis of the pragmatic applications it is a special concern to us to reach new spatial configurations to make the municipal space more exciting with the suggested method.

4. Working Examples

In this chapter we make experimental use of the methods which have been developed up to now. In the first step we will try to track down the rules of the development processes of exemplary settlement patterns and to generate analogous structures. Afterwards the possibilities of the methods worked out will be examined at the ”Franzosenviertel”, a planning area in Munich. It is an inner city area which is partly idle and lends oneself due to its size and the heterogeneous environment for our test designs.

4.1 Structural Differentiation

In the following, it will be looked at nine different structures to show the differences of the characteristic qualities and their variation by two different possibilities for development. With the chosen variants we try to show a wide spectrum from the endless space of possibilities. Thereby the relations of the parameter settings will be described which can be realised with the interface.

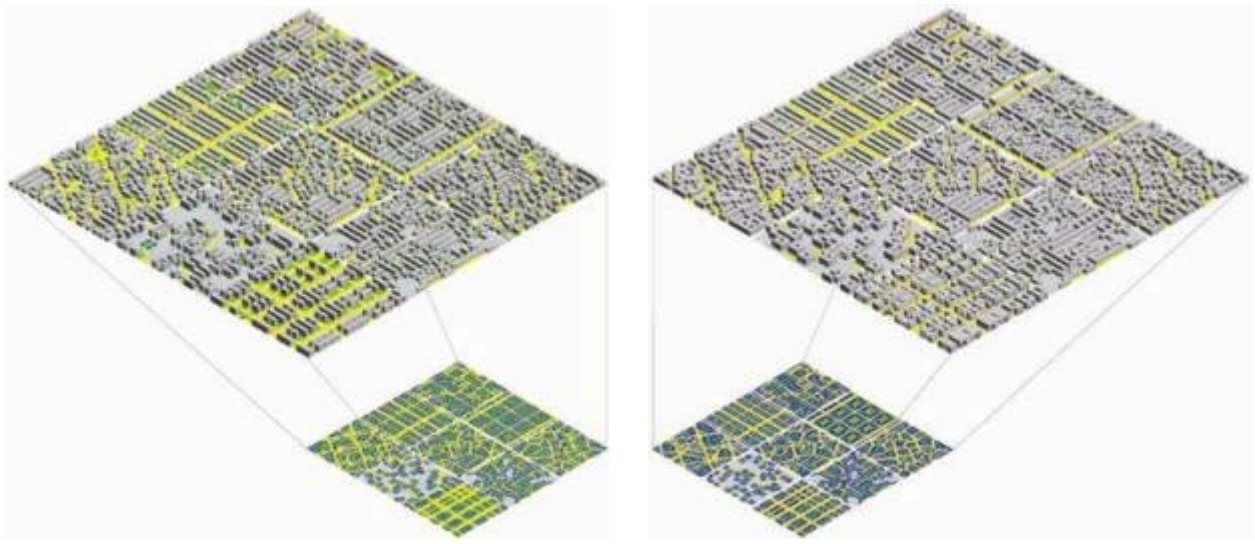

Figure 11 Examples for development possibilities of the different structures.

4.2 Franzosenviertel

The two examples shown on the following pages are built up after the same scheme: Starting from development structure which follows each time one topic like “Cluster” (Fig. 12) and “Ausleger“ (Fig. 13) three different possibilities are represented for a corresponding structure. This structure will be translated by different methods into three-dimensional buildings. The selected examples represent just a tiny part of the potential possibilities which depend on the chosen parameters.

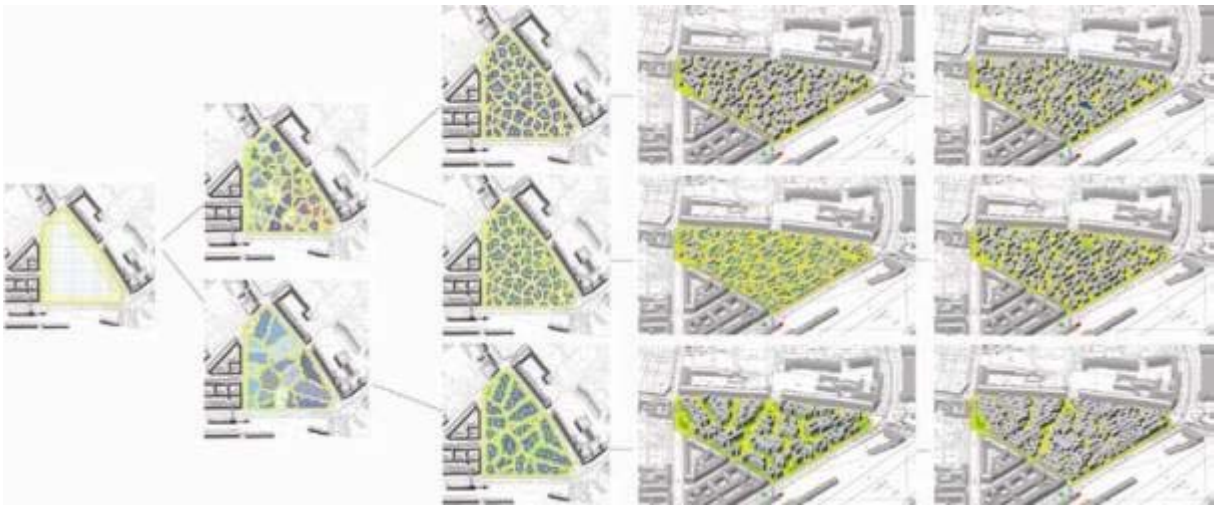

Figure 12 Examples for ‚Cluster’-structures

Figure 13 Examples for ‚Ausleger'-structures

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The complete work ‚Computer Generated urban Structures' is available in German at: http://www.entwurfsforschung.de/compStadt/compStadt.htm